

# Informatik - Fachberichte

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## Rechnernetze und Datenfernverarbeitung

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## DEVELOPMENTS IN EUROPEAN PUBLIC DATA NETWORKS

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### 1. INTRODUCTION

There have now been many superficial surveys of planned public data networks (e.g. Refs 1 and 2). It is not worth repeating that material in this paper, and yet the field is advancing sufficiently slowly that there is little new to report on such plans. Instead, in this paper we will first give, as background in §2, an overview of the expected demand for data transmission facilities in Europe, and survey in §3, the data facilities commonly available on the present day analogue telephone network. In §§4-7 we follow the earlier references in describing European data network activities, both circuit-switched and packet-switched, but not providing much technical detail. Rapid progress in international data communications is discussed in §8. This leads naturally to a discussion of activities in the interconnection of data networks of §9. The interconnection of national networks leads to a brief consideration of the potential impact of communications satellites (§10) on the field of data communications. In §11 we broach the serious problem of "data services", and how many of these impact, and may run foul of, the PTT monopolies. Finally, our conclusions are presented in §12.

### 2. DATA TRAFFIC REQUIREMENTS

Any discussion of data networks should begin with a consideration of the data traffic requirements. These can be presented in many different ways. One measure, shown in Fig 1, is the density of telephone sets versus Gross National Product. Ref 3 discusses how the traffic may be estimated, and how it may be expected to change over the next decade. The paper then presents the European data requirements by 1985 as in Fig 2. For more careful planning, it is necessary to consider the requirements in the different sectors. Again the EURODATA study (Ref 11) has tried to break down the requirements in different sectors. As an example, the potential number of users for bibliographic information retrieval is shown in Fig 3.

All the estimates depend critically on general economic factors. The type and tariffs of data transmission facilities will modify the demands by large factors. However, these estimates give a measure of the potential demand.

Different countries will develop in different ways. Policy, regulatory and tariff



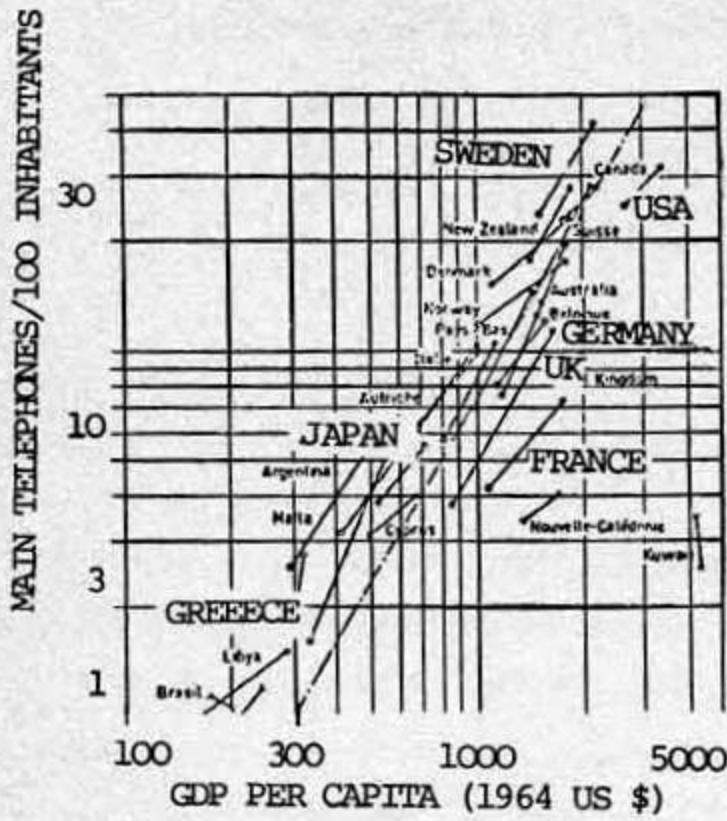


FIG 1: 1964 and 1968 Telephone Density versus Gross National Product (reproduced from Ref 3)

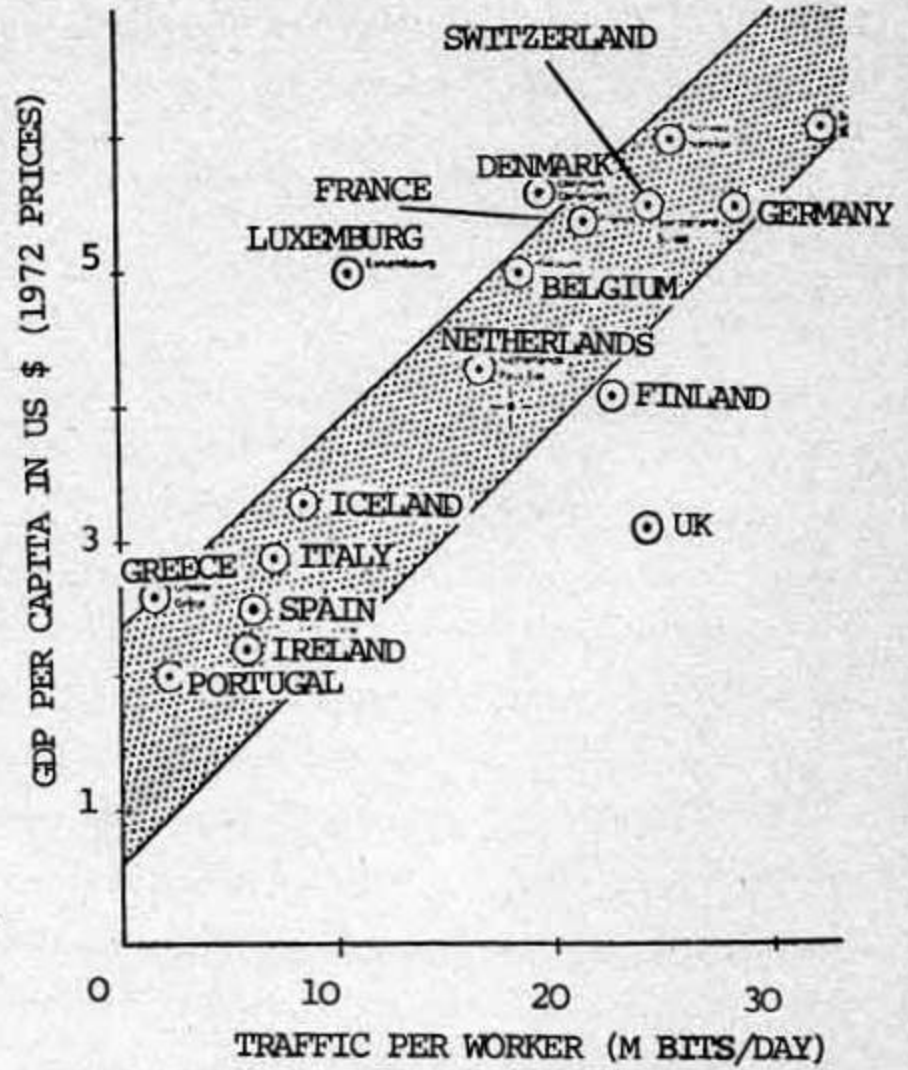


FIG 2: Estimated 1985 Gross National Product versus Data Traffic (reproduced from Ref 3)

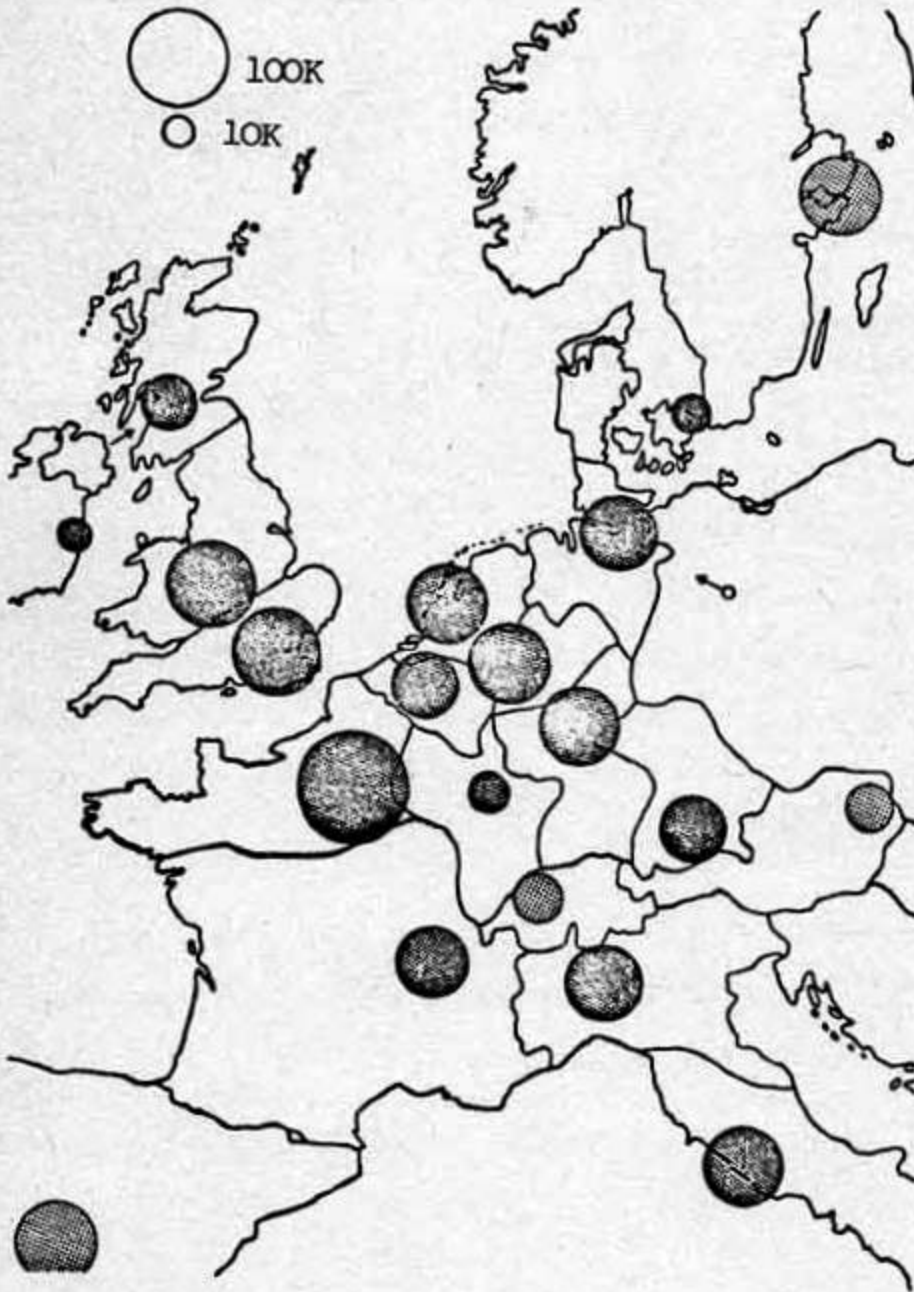
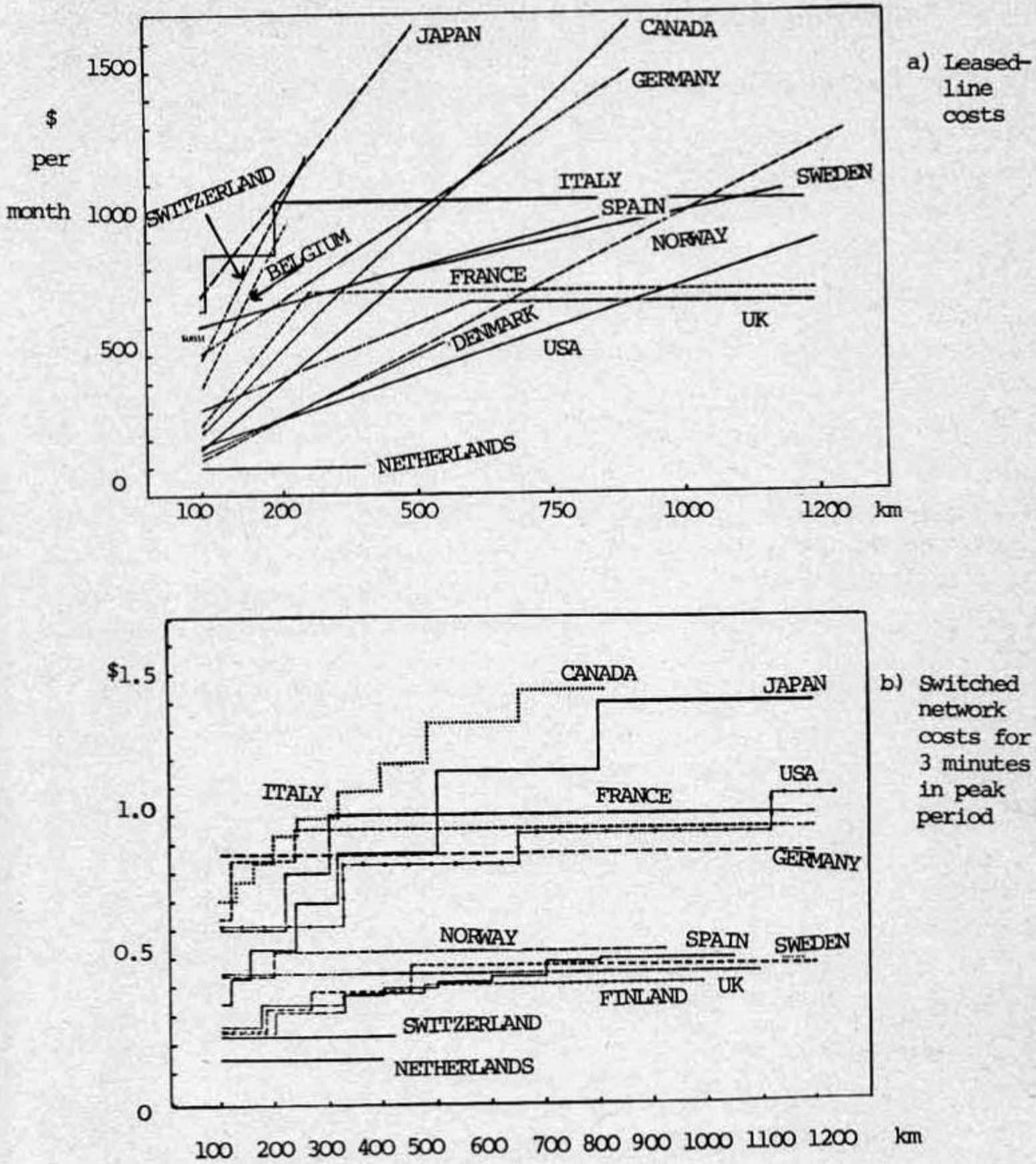


FIG 3: Users by Euronet region in 1980 (reproduced from Ref 4)

factors will cause the different developments. For example, the tariffs in different countries are shown in Fig 4.





These figures clearly show that a development, economic in one country may not be so in another. There are other differences. In all European countries there are monopoly powers for data and message traffic vested in government or other licenced bodies. In some countries these monopolies are strictly enforced. In most countries specific "affiliated groups", like airlines (Ref 7), or banks (Ref 8), are allowed to share communication facilities; in most general sharing is not allowed. However, in several countries (France, Belgium and Holland), it is permitted, at present, that TYMNET be used to offer European customers access to computers belonging to other organisations; the UK allows TYMNET to have a UK node, but instructs Tymshare to permit access only to its own computers (see also \$8).

In some countries any licenced modems can be put on the public switched or leased telephone networks (e.g. France). In others specific modems supplied by the PTT can be put on the switched networks; but any licenced ones on leased lines (UK). In yet other countries (e.g. the Federal German Republic, FGR), they propose to offer not a line and modem, but a service; the cost of the service depends on speed capability, so that a 9.6 Kbps service would cost more than a 4.8 Kbps - but eventually, the FGR would supply both modems and lines. Other countries may well follow the FGR lead.

It is based on such estimates, that the national PTTs must decide how best to meet the demands. It is based on the service, regulatory and tariff features, that the customers must decide in what way to use the facilities supplied by the PTTs. In some cases, for example, the volume of data may not justify the PTT putting in special data facilities; in others the demand may swamp the capacity of the public telephone system. Currently, the PTT may decide special data facilities are not justified; however, the tariff and service available (in noise performance or availability of switched lines, for example), may force organisations to set up leased private networks. On the whole, the PTTs in most European countries would like to provide as much of the value of such networks as possible, and feel this development is most economical in the long run. The purpose of this paper is to point out some of the European developments in this direction.

### 3. PRESENT DATA FACILITIES ON THE ANALOGUE TELEPHONE NETWORK

Many countries now offer data facilities on the public switched telephone network (PSTN), both with dialled and leased lines. A brief summary of the speeds and modes of signalling currently recommended by the international body CCITT (Comité Consultatif International Telegraphique et Telephonique) is shown in Table 1.



| Class                                  | 1   | 2   | 3    | 4    | 5    | 6      | 7                             |
|----------------------------------------|-----|-----|------|------|------|--------|-------------------------------|
| Rate (bps)                             | 200 | 600 | 2400 | 2400 | 4800 | 48000  | up to 10 chars in<br>parallel |
| Switched/<br>Leased                    | S,L | S,L | L    | S    | L    | L      | S                             |
| Async/Sync                             | A   | A   | S    | S    | S    | S or A | A                             |
| Duplex/Half-<br>duplex<br>2 wire lines | D   | H   | H    | H    | H    | H      | H                             |

TABLE 1: Commonly available facilities on the Analogue Telephone Network according to CCITT recommendations

The PTTs are somewhat conservative in their recommendations. They wish any service they offer to be available over most lines in the country. In fact, on most circuits of the PSTN of many countries, speeds of 4.8 Kbps are obtainable with certain sophisticated modems, and on leased lines 9.6 Kbps or even 19.2 Kbps. All transmission between exchanges on the PSTN are four-wire, and only on local lines are the PSTN circuits two-wire. Even over these, full-duplex speeds of 0.3 Kbps are usually obtainable. At the higher speeds (Services 2 and 3 in Table 1), return speeds of 75 or 150 bps can be obtained. Over leased lines, four-wire lines can be rented to the local exchanges, making duplex facilities at the relevant speed available. For 48 Kbps, special local lines are often required, and a full primary group of 12 telephone channels is usually used for the long distance transmission.

In fact, when digital transmission is used for the inter-exchange transmission, 64 Kbps is used for ordinary voice traffic. This mode of transmission is in the province of \$5.

Most of the PSTN connections of Table 1 imply electrical connections of the data terminal equipment to modems, which are themselves attached electrically to the telephone lines, bypassing the telephone handset (except in the call set-up phase). At the lower speeds, acoustic-coupled modems can be used; here the modem is connected electrically to the terminal equipment, and acoustically, through the telephone handset, to the line. In most countries, acoustic-coupled modems can reach 300 bps; in the US such modems are offered up to 600 bps. Often the higher speeds, up to 600 or 1200 bps in one direction, can be attained by exchanging the microphone in the telephone to one of better quality. Unfortunately, this substitution is illegal in most countries.



On the PSIN, the time to set up a call is most typically 20 secs, due to the switching times in the exchanges, most of which are electro-mechanical (Strowger). For data traffic, particularly with short transactions, a much shorter call set-up time would be a great advantage. Many of the newer electronic exchanges are achieving shorter call set-up times.

#### 4. PRESENT LINE-SWITCHED DATA NETWORKS

Two countries, France and W. Germany, have started introducing special line-switched data networks, without digital transmission. The second will become digital shortly, but is still mentioned in this section.

The French introduced in 1972, the Caducee system, based on an Ericsson CP 410 crossbar switch. It is a circuit-switched system for the speed range 2.4-72 Kbps, using analogue transmission. It is aimed at an interim solution to their data problems, and will be superseded by an all-digital system in the early 80's. It is being put in now mainly because of the poor quality of the normal telephone circuits. The system is based on 2000-line exchanges. Users can have access at up to 4.8 Kbps, directly to the exchange, or through a concentrator; within 30 km of an exchange, 19.2 Kbps access is possible with base-band modems. The same quality of four-wire lines is used as for leased telephone service. Call set-up time is six seconds, and there is out-of-band signalling via a touch-tone telephone.

A far more ambitious system, the EDS system (Ref 9), is being installed by Siemens for the Federal German Post Office. The system was developed initially for handling German Telex and Datex traffic at speeds up to 200 bps, but was designed to take also higher speed traffic. The system has been discussed in the reference, and is the subject of another paper; it will not be described in detail here. In its present form, the system is essentially asynchronous, but it is envisaged that synchronous operation will be added in 1978. The EDS system is the first serious data system in Europe, in that it has potentially a reasonably high capacity. According to early design figures, it should be able to handle several thousand asynchronous terminals at 200 bps, or 6K synchronous terminals at 2.4 Kbps. However, the time to set up calls is comparatively long - 20 ms. Thus at most 50 calls/sec could be set up. This implies that the EDS system is not ideal for short transactions. For comparison, in the packet-switching ARPANET IMP (Ref 10), it would be possible to generate an order of magnitude more short messages to different sites.

EDS will have facilities for abbreviated dialling, multi-address messages, calling station identification and closed user groups. Facilities for packet-switching, hot-line and delayed-delivery, have been announced on the EDS exchange by Siemens, but the German PTT has not said that they will provide these facilities. A prototype ex-



change has operated in Munich since 1972; the first real exchange at Mannheim started operation early in 1975. Another is scheduled to open in late 1976; thereafter, new exchanges will be introduced at the rate of 4-5 pa, so that there should be 21 in operation in 1980.

## 5. SYNCHRONOUS DATA NETWORKS

Many of the wide-spread computer networks have implemented a communication subsystem, which operates over the analogue telephone network. Some of these subsystems are described briefly in this paper. CCITT has studied the requirements for specialised data networks in their working party on New Data Networks (NRD). The CCITT is a consultative committee to the International Telecommunications Union, and its recommendations are usually followed by the national telecommunications administrations (PTTs).

The NRD has concluded that it is the declared intention by a number of PTTs to provide data services over synchronous networks. At the moment, the only facilities which will be provided by most such countries are for circuit-switched connections, in which a single channel is provided between two terminals. On the present analogue public switched telephone network, full-duplex facilities are usually provided only up to 200 or 300 bps, with half-duplex facilities up to 1200 or 2400 bps. The new networks will use pcm digital transmission, and plan to provide a number of user classes with full-duplex capability, as indicated in Table 2. The new networks are planned for introduction between 1975 and 1985, with many starting about 1980. For this reason, it is felt that a little information about these networks is of some importance. Further details are given elsewhere (Refs 1 & 2).

| Class | User data class                         | Address Selection and Service Signals (Alphabet No. 5) |
|-------|-----------------------------------------|--------------------------------------------------------|
| 1     | 200 bps 11 units/char start/stop        | 200 bps                                                |
| 2     | 50-200 bps 7.5-12 units/char start/stop | 200 bps                                                |
| 3     | 600 bps synchronous                     | 600 bps                                                |
| 4     | 2400 bps synchronous                    | 2400 bps                                               |
| 5     | 9600 bps synchronous                    | 9600 bps                                               |
| 6     | 48000 bps synchronous                   | 48000 bps                                              |

TABLE 2: Classes of User Service Recommended

Certain specific recommendations have been made on class 2, so that the combinations of speed and units/character match present terminals.



It is proposed that these new data networks have a public switched capability of making a call "reasonably fast"; however, the present set of recommendations do not seem to guarantee such a call being set up in less than 10 sec, or shut down in less than 1 sec. It is supposed to be symmetrically duplex, bit-sequence independent, with automatic calling and answering. It is recommended that direct call, abbreviated address and closed user groups be provided. Remote terminal identification, multi-address, and delayed-delivery for class 1 service may be provided.

The actual transmission between exchanges will be at a multiple of 64 Kbps (usually 2.048 Mbps in Europe, which uses 32 channels). It will usually share the same long distance transmission as the telephone system, but use different exchanges. It will use different terminating units to subscribers' premises from the present modems. In many countries, the new network is intended to carry the telex traffic, and possibly also facsimile.

There are a number of consequences of the need for inter-working between countries, together with facilities for complete bit-transparency. Several countries (particularly ATT and Canada) have opted for wishing to have a frame consisting of some synchronising or control bytes followed by data bytes:

SYN data data data ... SYN data data data SYN ...

Others have preferred to have each byte carry information on whether it is control or data, e.g.:

| Bit     | 1     | 2-7         | 8      |
|---------|-------|-------------|--------|
| Content | Frame | Information | Status |

TABLE 3: Frame format for synchronous data

Here for one value of status, the information is data, for another control. Denmark, Finland, W.Germany, Norway, Sweden and the UK, have opted for this system; France and Italy have said they would use both methods. The two systems will be kept capable of inter-working, because it has been agreed to use a 32-bit frame consisting of four 8-bit bytes. In the first scheme, there will be one control byte followed by three data bytes/frame; in the second each frame will have four bytes of which again up to 24 bits are data.

Since the control and framing information is put in by the switching exchanges, the relative transmission rates in the classes are shown below:



| Class                        | 1   | 2   | 3   | 4    | 5     | 6     |
|------------------------------|-----|-----|-----|------|-------|-------|
| Rate bps                     | 266 | 266 | 800 | 3200 | 12800 | 64000 |
| Repetition in 64 Kbps stream | 240 | 240 | 80  | 20   | 5     | 1     |

TABLE 4: Signalling speeds and number of bytes in 64 Kbps channel for data for a signal user class

The typical schematic of a system of this sort is indicated below:

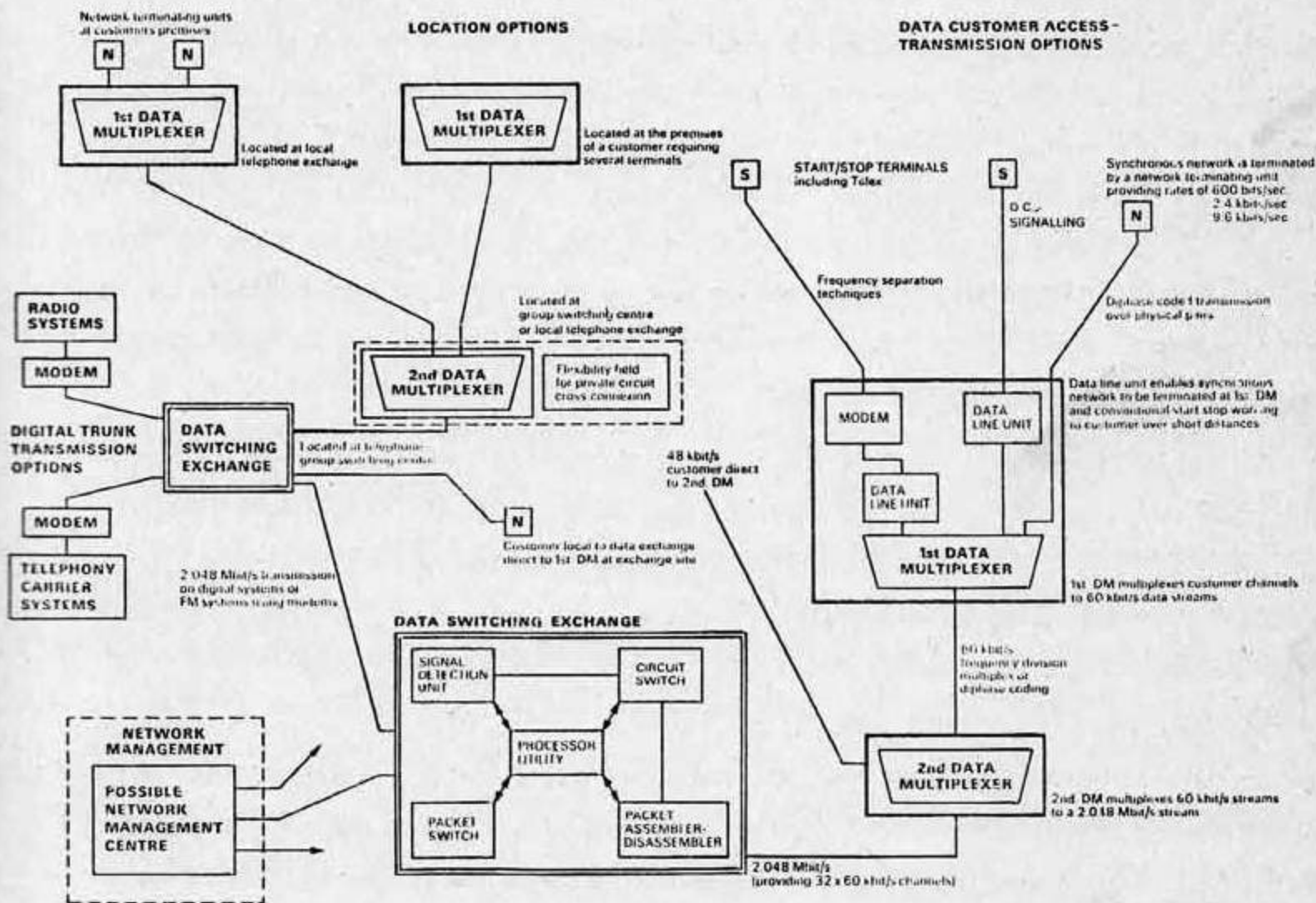


FIG 5: A schematic of the possible structure of transmission and multiplexing facilities in a new synchronous data network



In the above, it is shown how packet-switching (see §6) could be added to synchronous line-switched networks. No European PTT has committed itself to provide such a service, however. A 1971 UK estimate was that a Data Switching Exchange built to handle packets would cost only 15% more than one without, and the exchange costs only 25% of the whole network.

The PTTs of a number of countries have announced definite plans to introduce trial or production networks of this kind (without packet working). The Nordic countries, Denmark, Finland, Norway and Sweden are planning their systems together (Refs 12) although they are trying out different technical solutions. An explicit intention even in their trial networks, is a high-level network connecting Oslo, Stockholm, Copenhagen and Helsinki. Finland, Norway and Sweden will each have 3 nodes of their original trial systems. The Norwegian one has initially 72 Kbps transmission between nodes in 3 cities. At each city there is a 512 port multiplexor to subscribers' equipment, and between the subscriber and the multiplexor analogue transmission via modems is used. There is initially only leased-line service; switching may be added later. The Swedish system is somewhat more ambitious. It has a switching exchange in Stockholm, attached to concentrators in Stockholm, Malmo and Gothenburg. It has limited capacity, initially for only 100 terminals of different types. Transmission speeds of 2.4 Kbps are offered initially, with 9.6 Kbps and 600 bps following later; the customer interface is as for synchronous modems. This system uses something like the CCITT envelope scheme, and has a call set-up time of 100-200 ms.

Elsewhere in Europe, the Swiss have started experiments (Ref 13) to produce an integrated synchronous network including data, telegraphy and telephony. The UK (Ref 1) has put forward proposals on a special synchronous data network, and the French have a similar development. The W. Germans have announced how they will run the EDS network in a synchronous manner (Ref 9). Many other countries have indicated that they will follow suit.

This paper is concerned only with the European scene. The N. American is both more advanced and more complex, because that region has different provisions for a PTT monopoly. A good introduction to N. American activities is given in Refs 14-18. Japan has made tentative steps also towards data networks to start in 1976 (Ref 19).

## 6. PACKET-SWITCHING SERVICES

So far we have talked of new data networks where circuits are provided between the two ends. An added, or alternate, facility is to store the data in an exchange near the subscriber, and send it at higher speeds in packets to the recipient. This form of service called "Packet-Switched Service" permits a number of features to be added



more easily. These include speed changing between sender and receiver, and many sending stations multiplexing their data to one receiver (and vice-versa). Moreover, for bursty traffic, this system makes better use of the long-distance transmission medium - at extra cost in the switches. In the past, these systems have been used for message switching, in which whole long messages are stored and then forwarded. More recently, the same principle has been applied to short packets, typically 1-8K bits. Although data is transported inside the data networks in packets, there are still several ways data can be introduced into the network. In one method "virtual circuits" are set up. A process in the calling terminal (or computer) sets up a call to another terminal or computer. After the appropriate "dialling information" has set up tables in the switches nearest the source and destination, all subsequent data is routed automatically between source and destination. In some such systems, the data always follows the same path ("fixed routing"), in others, it can be switched along different paths depending on the instantaneous availability (or occupancy) of specific routes - this is so-called "adaptive working". When the data can follow different paths, it can happen, in some systems, that one packet can arrive after a subsequent packet. This type of "out of order" transmission cannot occur in other systems.

The "virtual circuit" approach is appropriate when substantial numbers of packets are to flow between two terminals or processes - in that case, the overhead of "setting up a call" may be justified. For short, single transactions, a pure isolated packet format is more appropriate. In this form of service, called "datagram", each packet contains the full routing information - so that no virtual circuit need be established in the data network.

Both the virtual circuit and the datagram have been the subject of considerable discussion in national and international standardisation bodies. Most public and private networks have so far used "virtual circuits" when they have been designed by PTTs, or have longer duration interactions in mind - these are more like the telephone calls familiar to the designers; when they are for single transactions, they have used datagrams. With both services, one can have speed-changing, and several conversations can be interleaved over one physical path.

In this paper I will treat only those data networks which are permitted to carry data traffic for the "public" in Europe. For this reason, I will exclude several US organisations like the General Electric-Honeywell Mark III (Ref 20), and the Tymshare TYMNET (Ref 21). These do operate in Europe, but are not carrying data "for the public", except to their own computers (though TYMNET does actually carry traffic also for other computers, as mentioned in §2). Nor will I treat the very important US



Networks - ARPANET (Ref 22) and its commercial offshot Telenet (Ref 23). The former does operate in Europe (Ref 24), but is only available for a specific research project. The latter is still restricted to the US. Other such networks are being set up in Canada (Refs 14 & 16), Australia and Japan (Ref 19).

#### 7. EUROPEAN NATIONAL PACKET-SWITCHED SERVICES

For a time the PTTs were unconvinced of the need for public packet-switched services, but many seem to have been persuaded recently. The requirements for Packet-Switched Services is now the official concern of Study Group VII of CCITT, and several PTTs have announced that experimental types of service of \$6 will be offered.

On the whole, the PTTs are more used to the "virtual circuit" concept, and two PTT-initiated experimental services in France (Ref 25) and the UK (Ref 26), use mainly this technique (though the UK system can be used to send datagrams also). The French experimental service, RCP, is operational; it has three nodes with three remote concentrators. In all, it has scope for carrying 120 connections. The internode line speed is 9.6 Kbps, and the speed to the concentrators 4.8 Kbps. Customers access the nodes over the telex or switched telephone networks (at speeds up to 300 bps), though some leased lines at 1.2 Kbps and 4.8 Kbps are also available. Subscribers can come into the network with arbitrary data streams of 8-bit bytes.

RCP is only a French PTT, and will never be available to the public. It will be replaced by a more sizeable system, TRANSPAC (Ref 27); this is scheduled to have its nodes operational in 1977, and to be open for service in the same year. TRANSPAC is designed to have its procedures downward-compatible with RCP. In its first version, it is designed to support 1500 terminals over six exchanges. However, the tender document envisages expansion of the initial exchanges by a factor of four. The original tender was for switches capable of handling each 125 synchronous and 125 asynchronous terminals, with a throughput of 500 Kbps. The basic design was to be extendable with the same technology by a factor of four to 1K terminals per switch. The tender also mentions that different mixes of asynchronous and synchronous terminals should be supported. The access to the switches will be by the conventional modem interface - the new interfaces for digital transmission may be added at a later date. They propose to allow access over the public switched telephone and telex networks at up to 300 bps, and leased telephone line access via modems, at speeds of 1.2 Kbps to 64 Kbps. There will be remote multiplexors to reduce access costs. Transit time between initial and final node is designed to be 0.25 sec, and undetected errors less than  $10^{-10}$ . Initially, the design was to support only virtual circuits, but a datagram service is also under study.



The UK Experimental Packet Switched Service (EPSS, Ref 26) is intermediate between RCP and TRANSPAC in scale. It is again based on three nodes, and is scheduled to be operational in early 1976. It has been designed to have very reliable packet switches, with at least duplexed operation (unlike RCP which has only single computers). In the first version, there will be 166 terminations with character interfaces, and 84 with packet interfaces. The character interfaces will be similar to those of RCP, and will all come over the PSIN at up to 300 bps or a related telegraph service. The packet interfaces will be accessed via leased telephone lines at 2.4, 4.8, and 48 Kbps. Unlike RCP, both datagrams and virtual circuits are offered. The EPSS nodes will be connected by 48 Kbps lines, and the switch design is expandable. It is possible to expand the number of nodes and their capacities. The procedures used are compatible with later replacement of the analogue transmission facilities by digital ones. One of the first places where leased digital service facilities will be installed is between the EPSS nodes. There is considerable discussion about taking the "E" off the service, and the system is designed for a factor of six increase of capacity.

One packet-switched service is already in service in Europe, being operated by the Spanish PTT (Refs 28 & 29). At present, it has nodes in Madrid and Barcelona with 700 terminals. Because it uses only leased lines, software in the nodes can deal with the present twelve specific terminal types without too much difficulty. The system is somewhat intermediate between a packet-switched and message-switched service, with both sets of facilities provided. The initial growth envisaged is rapid, to 7K terminals by 1978. At that time, there will be 9 remote concentrators and three switching centres. Eventually, the aim is to have switching centres in each Spanish province.

At present, there are leased lines at only 4.8 Kbps between the switching centres, and to the remote concentrators; the concentrators can support only 200 bps. The lines between the switching centres will be raised to 48 Kbps by 1977. By 1980 another three switching centres and 64 Kbps digital transmission between the centres, is envisaged, and the terminals will be supported at 2400 bps. At present, the terminals can each access only one computer on their "Real Time Service", with a 2 sec response; with their "Message Service", there is no such restriction. Shortly, the Real Time Service will incorporate switching. There is one difference between the Spanish service and the others of this section; the Spanish have established real tariffs, and know their costs. They expect to break even in 1976. The way in which their system is set up with large scale computers, leads to a cost of a factor 10 higher than a telex crossbar switch (Ref 29). They are therefore looking carefully



at adding a computer-controlled circuit switch to their data network.

Another packet-switched network now operational is CIGALE (Refs 30 & 31) in France. This currently has switching nodes in Paris and Grenoble, with concentrators in several other sites. This network offers only datagrams. It is not discussed in detail because it is not publicly available - it is in the same situation, from this point of view, as ARPANET. So far, it has almost no access to the public switched telephone network.

#### 8. INTERNATIONAL DATA NETWORKS

The present national data networks already have their political difficulties, the international scene is yet more hazardous. For example, Western Union International has used the potential saving from packet transmission to offer a private line service - International Digital Data Service (IDDS, Ref 32), in which data is sent in parallel across a cable and satellite circuit. Computers at either end compare the two sets of data which each have check sums, and pass the correct one to the customer. This technique would allow the carrier to give a high degree of assurance that the data passed is correct. In its early version, IDDS would provide for 50 bps Telex and 2.4 Kbps synchronous data traffic. Eventually, a mix of 9.6, 4.8 and 2.4 Kbps lines, and several speeds of asynchronous lines would be supported. The tariffs would be dependent on the volume of data; the charges made to many users would be substantially below those made for dedicated leased lines. The other US international data carriers have challenged the IDDS offering, so that it has not yet (end 1975) been approved by the FCC. Moreover, only certain European countries, Austria, France, Italy and Spain have agreed to the service so far - although other countries are studying it. Similar services between Canada and various European countries are also under discussion. Tymshare is trying to offer another Value Added service internationally. In France and Belgium it has had little trouble. In the UK the PO had proposed to allow their service only if they surcharged Tymshare for each hour of connect time at a terminal, and use leased lines; moreover, the PO would be licencing Tymshare to act as an agent of the PO. The whole question of Value Added services is under discussion by the European PTT consultative committee (CEPT). Two shared-use networks have been permitted, SITA (Ref 7) and SWIFT (Ref 8). The first is a message switching system for the airlines, which has many of the characteristics of national packet-switched networks. It has some nine packet-switched nodes in a high-level network; terminals and computers of the airlines are attached into the system which has been here for some years. There are other shared-use networks of this type in other industries. SWIFT is a system for banking, using two switches in Brussels and Amsterdam, due to go live in 1976. This has needed approval from all the various PTTs in Europe and N. America. Even in the case of SWIFT, the approval is only until the PTTs offer



a similar service - but there may be substantial discussion as to when a PTT service is equivalent! These systems are again essentially beyond the scope of this paper because of their closed nature.

In addition to the data services between Europe and N. America, the European countries in CEPT are discussing the set-up of an inter-European data network. A beginning in this direction is the European Informatics Network (EIN Ref 33). At present, while international, this network is to be a closed one, with nodes in London, Paris, Zurich, Milan and ISPRA. The nodes are designed to have interfaces with the national data and PST networks, and the EIN may in the future play a role as an international high-level network. So far, only the specifications for the communications subnet have been drawn up, and the contracts for the communication computers have been placed. However, who will be able to access this network, how it will be accessed, and what will be its role in relation to the national PTTs and their plans, are still moot points. The nodes are scheduled to be operational by May 1976. It is an indication of how the PTTs may treat such networks, that the UK PO is moving to restrict access to EIN to be only through EPSS. The national data networks in the other EIN countries are not yet sufficiently far ahead to make similar restrictions.

An interesting international use of data networks is developing which is causing some policy issues to be discussed. There are predictions that there is a large demand, as yet suppressed, for bibliographic information retrieval services (Fig 3 and Ref 4). One problem with these services is that the databases are so large, that they will usually need to be made available on an international basis. This is one of the applications for which TYMNET is used in the US, and for which UK PO permission was not forthcoming. The European Economic Commission (EEC) has proposed to set up a European Information Network (Ref 34), in which Hosts will be attached to some common data networks. The PTTs have proposed that they operate the network which may in the short-term be based on the EIN technology. One policy problem is that although the application is a dedicated one - so that the SITA and SWIFT precedents might be considered valid - the potential users will be widely distributed, and may indeed be any private citizen. It is for this reason that the PTTs are proposing to run the network themselves - thus ensuring that the shared access would not endanger their monopolies.

#### 9. INTERCONNECTION OF DATA NETWORKS AND THEIR USAGE

In §§2-8 we have surveyed the status of the various public data network activities. At first sight, these seem a motley collection of incompatible projects. However, there is excellent collaboration between the PTTs, and great emphasis is being placed on the ability to interconnect these networks. For the interim networks typified by §§3 & 7, interworking will be hard, and special gateways must be employed. However,



such gateway experiments are already being planned, and will be constructed within a year or two of the national networks being operational.

Considerable effort is being put in by the PTTs and other interested parties in assuring that common standards emerge; these efforts are being made through the international bodies like CCITT, the International Federation of Information Processing (IFIP), CEPT, and the International Standards Organisation (ISO). Several research and development organisations are setting up experiments, often in partnership with the PTTs, to try to identify the parameters required to allow the inter-connection of the different national and private networks (Refs 35-37).

The synchronous networks of \$5 are being designed with international compatibility in mind. It seems clear that with these networks, internetworking at much higher speeds should be possible and even economic. In Europe, one may expect the 48-64 Kbps rate to be standard about 1980, as the digital services come into being in the various countries, but the dependence of rates on distance will remain longer - though it should not be as steep as now. The impact of these changes will be striking. Already a US carrier (MCI) is offering a magnetic tape transfer service; at 50 Kbps a full length tape can be transferred in half-an-hour, at 1.5 Mbps it takes only one minute! At 50 Kbps, with data compression, an A4 page of facsimile typescript of text takes 4 secs, at 1.5 Mbps one can send 8 pages/sec. With machine-readable text, the rates are at least a factor of ten faster! Thus the advent of these data services will make fast facsimile and file transfer technically achievable, and probably even economic. Having such communications facilities, the possible uses of computer networks increase dramatically.

We must add a major caveat on these new data networks. Outside N. America, few tariff structures - and even fewer tariff rates have been published. The estimates of the growth of data traffic pre-suppose certain levels of tariffs. The existing tariffs are based usually on leased lines - with a strong distant-dependent charge, and a prohibition on shared usage. The tendency in the future will be to reduce the distance dependency of charges, and have a larger component dependent on actual volume of traffic; EDS (Ref 9), Telenet (Ref 23) and IDDS (Ref 32) already set the example.

Two problems may then arise. The cost of local access may be much higher to the user, increasing the cost of short distance communication. Secondly, certain applications may never develop because the tariff levels are fixed by comparison with existing services, such as Telex. Some of these problems would be eased if there was convenient interconnection between the new data networks and services on the existing telephone lines. Present indications are that there may be regulatory and tariff bars to such interconnection.



## 10. SATELLITE COMMUNICATION

A new element has affected long distance communication with the advent of the communication satellite (Refs 38 & 39). The use of satellites for data communication did not make any qualitative difference until 1975. Their existence made more intercontinental channels available, and helped to reduce the cost. However, with the onset of the SPADE system (Ref 40), a single voice channel could be used for 56 Kbps data. So far the resultant savings have hardly been passed on to the European users (though they have to N. America). It is the availability of comparatively cheap bulk intercontinental digital capacity which allows the lower IDDS rates of Ref 32 to be offered.

So far on normal offerings, the PTTs have not wished to distinguish between cable and satellite; they are, however, different media. Several applications are starting to use the multi-destination nature of the satellite. There are proposals to use it for multi-destination facsimile proposals for using Demand Access algorithms for sharing a single channel amongst many users (Ref 41). Through the use of small groundstations, there is the intention to provide a far better marine communication service (Ref 39) - this will allow new data network applications, but is only a vehicle to make them possible.

Several small scale experiments to investigate novel techniques using the intrinsic properties of satellites are just starting. Some of these use the INTELSAT satellites; others plan to use future European communications satellites like the Orbiting Test Satellite (Ref 42). These activities are unlikely to have noticeable general impact, unless either the PTTs relax their present attitude to users operating their own small groundstations, or provide special facilities themselves which use the feature which could be made available.

## 11. DATA SERVICES

Now that the data networks can be made to work, and even can be interconnected, great thought is being put into new utilisations. Here we immediately notice a problem. Many computer networks can provide at small extra cost, certain high value services; examples are message services (Ref 43), information retrieval services (Ref 34), and store and forward facsimile services. In some cases, the PTTs will be eager and able to provide the services; an example is the UK PO experiments with their Viewdata service for general information retrieval (Ref 44). In others, they may not be convinced of their economic viability - particularly for the general wide deployment expected of PTTs.

In a few cases, the PTTs may be institutionally ill-fitted, both from their marketing and internal organisation, to adjust adequately to users' requirements. Three examples of this immediately come to mind. In the 1960s, several European PTTs took a direct or



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indirect stake in data processing services; none succeeded in building up a viable business. The banks are setting up a banking network SWIFT already mentioned (Ref 8); as part of the Network Management structure, the SWIFT organisation takes responsibility for the messages it passes; it is fully insured to recompense the users for any losses due to transactions lost or misdirected in the network; such a policy is almost totally foreign to PTTs. Finally, message processing (Ref 43) may need highly reactive and specialised facilities put in for individual organisations. Such a fast reaction to users' requirements is often foreign to the way PTTs operate - though their reaction to the EEC EURONET proposal may be an interesting test case!

In general, the above considerations are leading to serious struggles on the role of PTTs versus private enterprise. The present conflict between Tymshare and some CEPT countries, the request to a PTT by another time-sharing company to be allowed to advertise "mailbox" facilities, the suit against the German Post Office on "restrictive practices", are all signs of this struggle. We must hope, and press, that the PTTs think over seriously, not only what services they may wish to develop, but also which they are best fitted to provide. Provided other services are not truly against the public interest, private enterprise should be permitted to meet needs the PTTs cannot accomodate - even if this requires a reappraisal of PTT monopoly functions.

## 12. CONCLUSIONS

Today special data networks have been put together and made to work; in a very few years many more will exist, technically could be interconnected, and should give far better facilities than now. The PTTs will also be providing such networks themselves - hopefully obviating the need for most of the private networks. With the technical facilities becoming available, customers are increasing the range of services they desire. Some of these are encroaching into areas traditionally a PTT monopoly.

It is to be hoped that the technical advances will continue without too much policy dispute. Customers should encourage the PTTs to produce their national and international networks - and press for tariffs and facilities consistent with technological advances. The PTTs should welcome the new applications and the growth in data traffic they will provide - and seek to retain control only on those segments they are fitted to serve.

Finally, we are all aware that the fundamental differences between data and voice traffic will be more difficult to define in the 1980s, as all voice traffic becomes digital. Neither the PTTs should be stampeded, nor the customers should force the PTTs to provide separate large data networks which may become white elephants within a decade. Such a development can only lead to high tariffs, strong customer dissatisfaction and waste of resources.



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